



IJCRR

Section: Healthcare  
Sci. Journal  
Impact Factor  
4.016  
ICV: 71.54

# Measurement of Renal Length and Width in Healthy Adults and Their Association with Various Parameters

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## ABSTRACT

**Objective:** To find out the renal length and width in the studied Nepali healthy individuals; to see whether they have any association with the age, gender, height, weight and BMI (Body Mass Index).

**Methods:** Ultrasonographic measurement of renal length and width were taken in 110 healthy persons (57 males and 53 females) who were screened for presence of any renal anomaly. Height and weight of these individuals were measured and BMI was calculated. The significance of linear association between variables was tested using Pearson's correlation coefficient where  $p < 0.05$  was considered significant and regression equation derived.

**Results:** The mean renal length for the right and left kidneys were  $9.77 \pm 0.98$  cm and  $9.94 \pm 0.86$  cm. respectively. The mean renal width for the right and left kidneys were  $4.08 \pm 0.63$  cm and  $4.18 \pm 0.86$  cm respectively. The renal length had statistically significant association with the weight ( $p < 0.01$ ) and BMI ( $p < 0.01$ ) but not with the age, sex and height of the individuals.

**Conclusions:** The renal length and width in this population was lesser than the reference values in international literature and the renal length had significant association with the weight and BMI of the individual. Also, in forensic practice if a dismembered body with intact kidneys is found, estimation of the weight of the individual can be done in this population..

**Key Words:** Kidney, Ultrasonographic, Weight, Age, Gender

## INTRODUCTION

The renal size is a vital diagnostic concern in urological and nephrologic practice when assessing patients likely to have renal disease. The standard anatomy text-books regards the adult kidney to be 12 cm long and 6 cm wide, <sup>1</sup> research articles however suggests the renal length and width to differ between ethnic groups and according to body size, age, gender and body mass indexes.<sup>2-7</sup> Therefore, discerning the normal population specific reference values of normal kidney is imperative to assess any alterations that might happen in that population. Patients with renal problems typically go through ultrasonography of their kidneys which being simple, cost-effective, and harmless; having very petite interobserver changeability endows the doctor with crucial anatomical facets of the kidneys.<sup>8-11</sup>

Renal length and width are significant clinical factors in the assessment of patients having various renal diseases,<sup>12</sup> still there are very few studies essentially devised to evaluate renal dimension in healthy adults without any renal disease.<sup>13, 14</sup> Nevertheless, few researchers have given the ultrasonographic reference values for renal length in healthy individuals<sup>15-17</sup> but such studies are lacking in Nepal. Though population based large studies are needed to ascertain the normal reference values for Nepalese individuals, in this study we determined the ultrasonographic renal length and width in a group of healthy individuals with no known renal disease and assessed the effect of age, gender, height, weight and BMI which will be valuable radiologically while investigating renal disease in this population and forensically in cases where dismembered body parts are found and identification of the individual is to be made.

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Received: 22.01.2017

Revised: 02.02.2017

Accepted: 13.02.2017

## MATERIALS AND METHODS

The ultrasonographic measurement of renal length and width were taken in 110 healthy persons aged 15-80 years from 1<sup>st</sup> October 2015 to 31<sup>st</sup> October 2016 who were screened for presence of any renal anomaly in the department of Radiology at Nobel Medical College and Teaching Hospital, Nepal. Ethical clearance was obtained from the Institutional Review Committee of Nobel Medical College. Only asymptomatic patients having normal serum creatinine level and normal calculated creatinine clearance using the Cockcroft-Gault formula to establish the estimated glomerular filtration rate<sup>18</sup> were chosen and individuals having any disease that could affect renal length and width were excluded. A general physical examination of these individuals was performed and vital parameters like respiratory rate, pulse rate, systolic and diastolic blood pressure recorded. The weight of the individuals was taken on a digital scale whilst dressed in an examination gown over undergarment, and height was measured using a wall-mounted measuring scale with the patient standing barefoot. Body Mass Index (BMI) was determined with the height and weight of the individuals.

Digital renal ultrasound was performed with a “SIEMENS ACUSON X 300 Ultrasound System” (Simens Healthineers). Highest frequency curved linear array probe possible was used and scanning was initiated with 7MHz and worked down upto 2 for hefty individuals. The depth of penetration required was evaluated and adapted. The renal dimensions measured include length (distance pole to pole) and width (transversal axis) in centimeters. All ultrasonographic assessments were carried out by one experienced radiologist to eliminate inter-observer disparity.

## STATISTICAL METHOD:

The obtained data were statistically analyzed using the SPSS® for Windows, Version 17.0. Continuous variables means were evaluated using the Student t test. Regression equations and coefficients of correlation were obtained for each pair of variables. In order to find the association of renal length and width of the individual with age, gender, height, weight and BMI, the significance of linear association between variables was tested using Pearson's correlation coefficient where  $p < 0.05$  was considered significant.

## RESULTS

Out of the entire 110 individuals, 57 were males and 53 females. The mean age was  $35.58 \pm 15.45$  years;  $37.66 \pm 17.44$  years for males and  $33.33 \pm 12.76$  years for females. The mean right kidney length was  $9.77 \pm 0.98$  cm and that for left was  $9.94 \pm 0.86$  cm. The mean right kidney width was

$4.08 \pm 0.63$  cm and that for left was  $4.18 \pm 0.86$  cm. When the observed parameters were compared between males and females (Table 1), it was found that the only parameters to show significant differences were weight and height. Though not significantly, but the length of female kidneys were lesser than the male kidneys.

**Table 1: Various parameters in total subjects, males and females.**

Parameter	Total (n=110)	Male (n=57)	Female (n=53)	p-value
Mean Age (years) $\pm$ STDEV	35.58 $\pm$ 15.45	37.66 $\pm$ 17.44	33.33 $\pm$ 12.76	n.s.
Mean RK Length (cm.) $\pm$ STDEV	9.77 $\pm$ 0.98	9.88 $\pm$ 1.01	9.63 $\pm$ 0.94	n.s.
Mean LK Length (cm.) $\pm$ STDEV	9.94 $\pm$ 0.86	9.97 $\pm$ 0.77	9.89 $\pm$ 0.96	n.s.
Mean RK Width (cm.) $\pm$ STDEV	4.08 $\pm$ 0.63	4.06 $\pm$ 0.63	4.09 $\pm$ 0.63	n.s.
Mean LK Width (cm.) $\pm$ STDEV	4.18 $\pm$ 0.86	4.1 $\pm$ 0.95	4.21 $\pm$ 0.75	n.s.
Mean Height (cm.) $\pm$ STDEV	160 $\pm$ 6.75	167 $\pm$ 6.8	153 $\pm$ 6.7	<0.0001*
Mean Weight (cm.) $\pm$ STDEV	73.04 $\pm$ 12.13	78.45 $\pm$ 11.92	67.26 $\pm$ 9.44	<0.0001*
Mean BMI $\pm$ STDEV	28.5 $\pm$ 9.5	28.9 $\pm$ 5.4	28.1 $\pm$ 6.6	n.s.

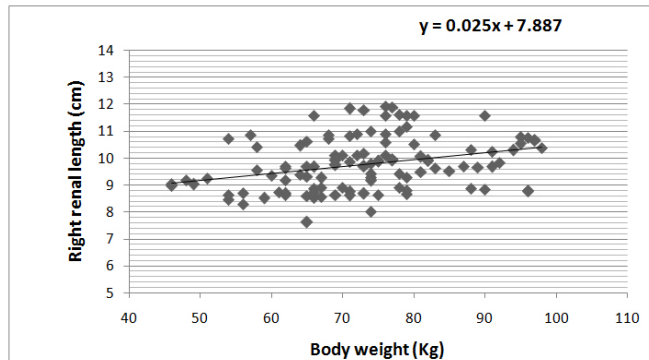
n = Total number; STDEV = Standard Deviation; RK = Right Kidney; LK =Left Kidney; n.s. = not significant

Statistical significant difference in kidney length and width between right and left side was not found. The right and left renal length had a significant correlation with weight (for right kidney R score = 0.32,  $p < 0.01$ ; for left kidney R score = 0.81,  $p < 0.01$ ) but not with height (R score = 0.18,  $p = 0.059$ ) and age (R score = 0.02,  $p = 0.86$ ). Fig.1 and Fig. 2 shows scatter diagrams of mean right and left renal length with body weight respectively. The left renal length had more significant correlation with weight as compared to left renal length's correlation with weight. The BMI being dependent

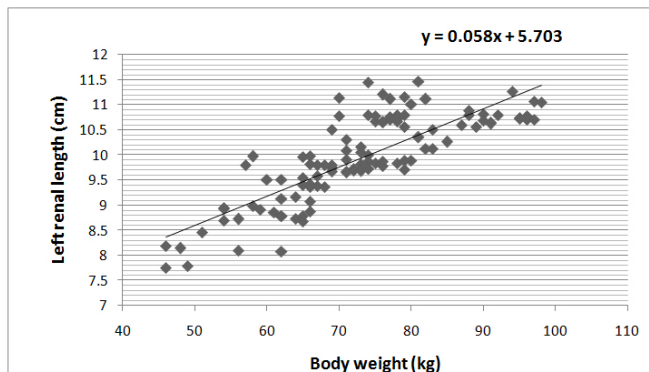
on body weight, showed a correlation with renal length ( $p < 0.05$ ). Linear regression equations for predicting variable (renal length) from independent variable (body weight) were obtained as follows:

Right Renal Length =  $0.025 \times \text{Body weight} + 7.887$ ; and

Left Renal Length =  $0.058 \times \text{Body weight} + 5.703$ .



**Figure1:** The correlation between right renal length and body weight.



**Figure 2:** The correlation between left renal length and body weight.

## DISCUSSION

Our study faction of 110 individuals showed a mean kidney length of  $9.85 \pm 0.92$  cm and width of  $4.13 \pm 0.74$  cm. This shows that this group had mean renal length and width smaller than reference values presented in international literature, probably an expression of the comparatively smaller body size.

The significant correlation of renal length with body weight that has been found in our study has also been observed in previous studies.<sup>19-21</sup> A likely rationalization is based on Brenner's principle of right renal dosing which states that bigger body mass requires a bigger nephron dose to meet its metabolic demands<sup>21-24</sup> and hence a bigger kidney. In clinical practice, the body weight can be easily recorded and right and left renal length can be easily calculated by our regres-

sion equation to compare the actual renal length with the renal norm in this population, even in rural areas where ultrasonographic facilities are not available. In forensic practice, at times, dismembered body parts may be brought for identification of that individual. If right and/or left renal length is known, then the body weight of that individual can be estimated by our regression equation in this population which will be of immense help to the forensic experts in identification of that individual.

The finding that there is no significant difference in renal length between males and females is consistent with other studies.<sup>21, 25</sup> Though, some studies reveal renal length to be greater in males<sup>19, 20</sup> but statistically significant difference will not be found if males and females of comparable body weights are analyzed.

A preliminary study done in Nepalese population found the length and width of the right kidney to be  $85.25 \pm 10.7$ mm. and  $50.65 \pm 5.8$ mm. and that of the left  $91.65 \pm 9.2$ mm. and  $53.65 \pm 5.2$ mm. respectively.<sup>26</sup> Our finding is not in accordance with this study because this study was done in normal-appearing formalin-preserved adult kidneys using a sliding caliper for measuring the length and width.

In our study, the height of the person had no correlation with renal length. The limitation of our study was that it did not reflect on parameters like race, culture, ethnicity and socioeconomic status, and owing to the small sample size, our study does not represent the whole Nepalese population. Population-based larger studies are required to ascertain the normal values for Nepalese.

## CONCLUSION

This study has given measurements of normal renal length and width in the studied Nepali population. We state that the mean renal length and width in this population was lesser than the reference values presented in international literature and the renal length increased significantly with the weight and BMI of the individual. Renal length can be estimated quickly by measuring the body weight and applying our regression equation even in the absence of ultrasonographic facilities in rural areas. Also, in forensic practice if a dismembered body with intact kidneys is found, we can estimate the weight of the individual in this population which will help in the identification of that individual. A large population based study is required to ascertain reference ranges of renal dimension in Nepal.

## ACKNOWLEDGEMENT

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references

of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

### Ethical Clearance

Ethical clearance was obtained from the Institutional Review Committee of Nobel Medical College and Teaching Hospital, Biratnagar-5, Morang.

### Source of Funding

None declared.

### Conflict of interest

None declared.

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